Testimony of Marc Wallace, Q.E.P.
On Certain Outdoor Wood-Burning Furnaces (SB 830)
To the Connecticut General Assembly – Committee on the Environment
February 9, 2011

Good afternoon Chairmen Meyer and Roy, and members of the Committee. My name is Marc Wallace. I am a Senior Air Quality Scientist at Tech Environmental, Inc. and appearing on behalf of the Hearth, Patio, and Barbecue Association. I have 23 years of experience as an air pollution consultant here in New England and have authored many reports air quality studies on Outdoor Wood Furnaces (OWFs), including the one submitted with my written testimony.

Senate Bill 830 is not needed. Public Act 05-227 enacted in 2005 eliminates potential smoke complaints by requiring OWFs be installed with proper set-back distances and a chimney height above the roof peak of residences not served. The existing law provides enforcement powers to the Connecticut DEP and to local Boards of Health. Enforcing the existing law protects air quality and public health.

EPA test data reveal that a properly installed OWF has the same Particulate Matter emissions as an EPA-certified wood stove for the same load of wood fuel.[1] An OWF installed and operated in compliance with Public Act 05-227 does not impact neighbors or adversely affect public health. Using EPA test data, air dispersion modeling studies prove a properly-installed OWF fully complies with National Ambient Air Quality Standards (NAAQS) for fine Particulate Matter ($PM_{2.5}$), established to protect public health for the most sensitive individuals with a margin of safety. Thus, there is no factual basis for banning the use of existing OWFs that meet current law. For the new EPA-certified Phase 2 furnaces, air concentrations are insignificant as defined by EPA. Copies of both studies are provided with my testimony.

[1] Guldberg, P., "Outdoor Wood Boilers – New Emissions Test Data and Future Trends," presented at the EPA 16th Annual International Emissions Inventory Conference, Raleigh, NC, May 2007. http://www.outdoorfurnacefacts.com/cms/repository/media/16th_Annual_International_Emission_Inventory_Conference_Guldberg_Paper.pdf.

The recent report by David Brown of EHHI has serious defects, as revealed in the expert's review report attached to my testimony. David Brown failed to use the EPA method for measuring fine particles in the air, and he refused to apply the EPA health standard. The expert's review found his measurement data to be contaminated and meaningless, and as a result all of the conclusions in the EHHI study are invalid.

When properly sited and operated in accordance with Public Act 05-227, OWFs are a clean and affordable heating source for homeowners in Connecticut and they do not impact public health. I urge the Committee to reject SB 830. Thank you.

TECH environmental
FOCUSED KNOWLEDGE. REAL SOLUTIONS.

November 24, 2010

Mr. David McDonald
Environmental Relations
Central Boiler, Inc.
20502 160th St.
Greenbush, MN 56726

Re: Improper Science in the Report "The Dangers to Health from Outdoor Wood Furnaces"

Dear Mr. McDonald:

I have reviewed the report by David Brown of EHHI, Inc. entitled "Dangers to Health from Outdoor Wood Furnaces" (2010). This is a classic example of "junk science" that contains blatantly false and misleading statements. David Brown appears to be an activist driven by non-scientific motives to oppose Outdoor Wood Furnaces (OWFs), which are a clean, safe, and economical method for heating a family's home. To the layman, the contents of Brown's report invoke fear because he or she does not understand that Brown's "danger" claim is not based on proper science. For example, Brown failed to use the EPA method for measuring small particles in the air that is required if one is investigating health effects. And, he failed to use the well-researched EPA health standard. As proven below, the measurement data in the EHHI report are contaminated and meaningless, and as a result all of the report's graphs and its dire conclusions are invalid.

Due to the large number of errors in David Brown's report, I have organized my review comments into three sections: Methodological Errors, False Statements Regarding Health Standards, and False Statements Regarding OWFs.

Methodological Errors

All of David Brown's data, graphs and conclusions rely on measurements of the number of particles in the air made with a Dylos DC1100 Pro Air Quality Monitor (Report, p.20). Close examination of this device reveals it to be a consumer product and not a scientific instrument. It does not measure airborne particulate matter (PM) in the units used by public health officials (the mass of the particles per volume of air); instead, it just counts the number of particles. Particle size and mass (weight) are the key measures that must be known in monitoring air quality. The DC1100 does not provide usable information for either of these measures. As a result, the data Brown presents are meaningless with regard to health impacts.

The mistake of trying to pass off a consumer product as a valid scientific instrument for measuring inhalable PM is surpassed, however, by Brown's apparent lack of knowledge regarding the most basic concept of PM epidemiology: *only very small particles reach the lung and pose a risk to public health.*

Consistent with this principle, EPA's Federal Reference Method for measuring fine PM only collects and weighs the smallest particles, those with a diameter of 2.5 microns[1] or less, and it excludes all larger particles with a size-separation inlet. This fact is crucial: the EPA health standard for inhalable PM requires the measurement of particles that are 2.5 microns *and smaller* in size. We breathe in millions of larger particles everyday that are harmless because they are large enough to be filtered out by multiple structures in our nose, nasal passages, throat, and upper respiratory system; these include pollen grains, mold spores, windblown dust, and house dust. Obviously, any instrument that counted these common, large particles would be useless in providing data with regard to public health effects, and using such data would produce a fictitious high level of PM. Yet, Brown's DC1100 Monitor does just that: *it counts all large particles.* This contamination of the measurements enables Brown to falsely claim impacts on human health.

The attached literature from Dylos clearly states that the Large Particle Counter "is calibrated to 2.5 microns and above" and the Small Particle Counter detects "particles down to 0.5 micron." That is, it counts all particles that are *larger* than 2.5 microns and 0.5 microns, respectively, including pollen, road dust, carpet fibers, etc. all the way up to any size particle that will pass into the inlet.[2] Further confirmation of this error is found in the Frequently Asked Questions (FAQ) section of Dylos' web site (attached), which confirms the particles the device measures are those *larger* than the stated size cut-points. This method is the exact opposite of what is required of measurements for assessing health effects. David Brown's methodology is completely upside-down and all of the data in the EHHI report are therefore worthless with regard to health effects.

The full list of methodological errors is as follows:

- EPA's health standards for PM are *gravimetric*, i.e. they require one to measure the mass of particles in a given volume of air. Brown did not measure particle mass, he only counted the number of particles, information that is meaningless with regard to public health standards.

- Brown failed to use the EPA Federal Reference Method for measuring fine PM ($PM_{2.5}$). EPA has established a Federal Reference Method (FRM)[3] for accurately measuring $PM_{2.5}$ levels in the air for the purpose of comparing such measurements to the health standards. Instruments that have been certified as FRM are air samplers that capture PM on a Teflon filter for gravimetric analysis and weigh the collected particle mass. Instruments not certified as FRM cannot be used to determine compliance with EPA's health standards. The Dylos DC1100 that Brown used is a consumer product; it is not FRM-certified and does not measure the mass of inhalable particles. It cannot be used to determine compliance with EPA health standards.

- No meteorological data are provided; thus winds may not have been blowing from the outdoor Wood Furnaces (OWFs) toward the houses in question during the days air monitoring was done. There is no evidence that the particles he measured originated from an OWF.

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[1] A micron is one-millionth of a meter. For comparison, the average width of a human hair is 100 microns.

[2] These facts were also confirmed by telephone with a Dylos technician: Personal Communication, Carol Unger, Dylos Corporation, April 2, 2010.

[3] 40 Code of Federal Regulations Part 53, Ambient Air Monitoring and Equivalence Methods.

- No tests were done to identify the source of the claimed particles inside the homes. Any number of indoor or outdoor sources could have been the cause. For example, one house has an indoor gas stove, another has a woodstove, another has a fireplace, and three of the houses have oil furnaces, all potential sources of indoor PM emissions. The report fails to report on activities known to stir up dust into the air inside a house: vacuuming, cooking, and the amount of foot traffic.

- Brown's report provides no information on standard design parameters for a proper air monitoring program, such as whether instrumentation meets EPA requirements for the PM monitoring, instrument calibration, or quality assurance procedures.

- When the Dylos DC1100 Monitor Brown used is set for "2.5-micron particles," it does not measure particles smaller than 2.5 microns, namely those that can penetrate into the lung. Instead, the DC1100 PRO only counts particles *larger* than 2.5 microns, namely the particles that are *not inhalable*. By counting pollen grains, carpet fibers and house dust and claiming these are "hazardous components of wood smoke" (Report page 16), Brown creates a fictitious "danger." These serious errors reveal that his data, graphs and conclusions are meaningless with regard to health impacts.

False Statements Regarding Health Standards

- To interpret the Counts of Particles data, Brown lists an "EPA Air Quality Index for $PM_{2.5}$" (Report Page 22) stated in terms of particle counts per 0.01 ft^3 of air. Brown's Index is a complete fabrication and he fraudulently uses EPA's name in the table's title. EPA has published no such index based on counts. The EPA health standard is defined by particle mass, which Brown did not measure.

- Brown lists "EPA air standard equivalent" on his Counts of Particles graphs (Report, pages 22-26). EPA has published no such equivalent, and Brown's listing of such is a complete fabrication.

- EPA has a well-researched and defined National Ambient Air Quality Standard[4] for $PM_{2.5}$ levels in the air. It requires the measurement of particle mass for particles with a diameter *smaller than* 2.5 microns using a FRM-certified instrument. It is defined for a 24-hour exposure period. Brown could have measured $PM_{2.5}$ properly and compared the results to the EPA health standard for $PM_{2.5}$, but he chose not to.

- Brown's statement that EPA considers $PM_{0.5}$ to be "most dangerous to human health" (Report Page 16) is false. There is no EPA health standard for $PM_{0.5}$ levels.

[4] 40 Code of Federal Regulation Part 50, National Ambient Air Quality Standards.

- Brown's discussion of wood smoke (Report pages 10-13) is highly misleading. Burning wood, in fact burning any fuel including natural gas and heating oil, produces trace amounts of several pollutants. Those he lists, including so-called "toxic air pollutants," are also found in the combustion exhaust for all fuel burning appliances, including the family car (fueled with gasoline), and the family home heating system (fueled with oil or gas). It is not the presence of trace amounts of such pollutants in undiluted flue gas that is important, but rather the concentration in the air after the exhaust is diluted and dispersed.

- Air quality studies have demonstrated that OWFs installed in compliance with manufacturer's instructions pose no risk to public health and fully comply with all air quality health standards.[5,6] Those studies reveal that properly-installed and operated OWFs comply with all air quality health standards, and pose no risk to people in both the outdoor and indoor environments.

- The claim that "there are currently almost no regulations restricting it [wood smoke exposure] or protecting neighbors" (Report page 5) is false. The EPA has promulgated National Ambient Air Quality Standards that apply to all outdoor locations and protect the most sensitive members of the population from known adverse health effects with a margin of safety. In addition, all States have their own set of air quality health standards for a variety of pollutants to further protect public health.

False Statements Regarding OWFs

- Brown's claim that "the State of Washington has banned Outdoor Wood Boilers/Furnaces" (Report pages 7 and29) is false. Washington State has taken the position that their existing regulations for indoor woodstoves also cover OWFs. While manufacturers dispute that interpretation, OWFs are available on the market today that are cleaner-burning than indoor woodstoves.

- Brown states that wood smoke from an OWF is "cool" and "will fall to the ground" (Report page 6). This is a false statement. Like all fuel burning devices, the flue gas from an OWF rises quickly into the atmosphere due to two effects: momentum and buoyancy. Buoyancy plume rise is the dominant force that lifts the plume from an OWF up and away from the ground; the average temperature of OWF flue gas is 350° F and far hotter than outside air. Most of the visible portion of an OWF plume is condensed water vapor (steam). When water vapor condenses in a plume the released heat of condensation causes further plume rise.

- Brown states that wood smoke from an OWF "is much cooler than smoke from other wood-burning appliances," referring to woodstoves (Report pages 6 and 7). This is also untrue. Woodstoves and OWFs operate in a similar manner at varying burn rates depending on the air damper setting. Both have a hot flue gas.

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[5] Guldberg, P., Rossi, R., and Sheadel, D., Air Quality Dispersion Modeling of Outdoor Wood Hydronic Heaters, April 2007.
[6] Guldberg, P. and Wallace, M., Air Quality Dispersion Modeling of the E-Classic 2300 Outdoor Wood Hydronic Heater, June 2009.

- The report's statement that "The Manomet study shows that, per unit, wood releases more climate-damaging gases than coal" (Report page 15) is false. The Manomet study deals with biomass substitution for fossil fuels in large electric-generating stations and its conclusions do not apply to home-sized OWFs. Data published by the EPA reveal that CO_2 emissions from burning wood are less than those from burning coal on the standard heat-input basis.[7] But these two fuels are not comparable for a climate analysis because wood combustion is not counted by EPA or international organizations as a greenhouse gas; "it is carbon neutral" and poses no threat to the climate.[8]

- The report's claim that Phase II (cleaner) OWFs "are still emitting more than 12 times the amount of wood smoke that an indoor wood stove is allowed to emit under EPA regulations" (Report page 28) is false. Under EPA Phase II labeling rules, OWFs can emit no more than 0.32 lb of PM per million Btu heat input.[9] That limit is far more stringent than the current emission limit (New Source Performance Standard) for non-catalytic woodstoves of 7.5 g/hr, which equates to 0.74 lb of PM per million Btu heat input. [10]

The EHHI report is derived from work David Brown published in 2007 (Report, reference 34). A peer review[11] of the Brown article performed by Gradient Corporation, a respected independent environmental health consulting firm, found Brown's article makes assertions about health risks from outdoor wood furnaces that are blatantly false, woefully inadequate and seriously misleading. A second peer review[12] of the Brown article in 2008 was performed by Exponent, experts in epidemiology and exposure assessment. Exponent found significant flaws in Brown's risk assessment, including faulty logic, false citations to the literature, and incorrect methodologies. Exponent concluded the Brown article "represents extremely poor and sloppy science" and "should not be relied upon for policy decisions."

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[7] U.S. EPA, Air Pollutant Emission Factors, Publication AP-42, Tables 1.6-3 and 1.1-20.
[8] U.S. EPA, Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2004, Publication EPA-430-R-006-002, April 2006, page 3-1.
[9] http://www.epa.gov/burnwise/pdfs/FAQs10-22-08VT.pdf.
[10] Guldberg, P., "Outdoor Wood Boilers – New Emissions Test Data and Future Trends," presented at the EPA 16th Annual International Emissions Inventory Conference, Raleigh, NC, 2007.
[11] Christopher M. Long, Sc.D., Senior Environmental Health Scientist, Gradient Corporation, "Comment on the Brown *et al.* Article 'An Assessment of Risk from Particulate Released from Outdoor Wood Boilers," letter to the Editor of *Human and Ecological Risk Assessment*, February 2007.
[12] Exponent, Inc., "Evaluation of Brown et al. (2007) article 'An Assessment of Risk from Particulate Released from Outdoor Wood Boilers,' " Alexandria, VA, September 2008, 24 pp.

There is no scientific foundation for Brown's recommendation that the federal government and the States "should ban OWFs" (Report page 30). When OWFs are installed and operated in accordance with the manufacturer's instructions, they create no adverse health effects.

Thank you for the opportunity to comment on the EHHI report authored by David Brown.

Sincerely yours,

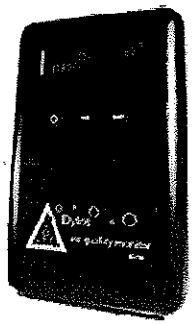
TECH ENVIRONMENTAL, INC.

Peter H. Guldberg

Peter H. Guldberg, C.C.M.
President
2618/Letter Oct 28 2010

Dylos Corporation

air quality monitoring innovation



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Dimensions: h 7 in x w 4.5 in x d 3 in

Total Weight: 2.5 lb

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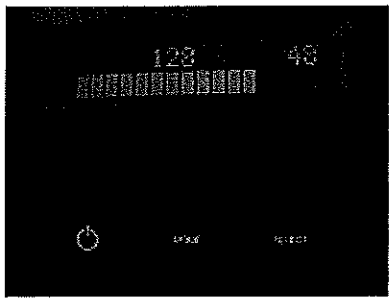

The DC1100 Air Quality Monitor has been engineered to be simple to use and simple to read. However, below are some frequently asked questions that will make understanding and using our monitor even easier.

What do the two numbers mean?

These numbers represent the number of small(fine) and large(coarse) particles detected. They are a running average of the particles counted in the past 10 seconds. The number on the left is the small particle count and the number on the right is the large particle count. The numbers are approximately what a 12 year old would inhale in a single breath. The small particles can include fine dust, bacteria, mold, smoke, etc. (from approximately 1um and up). The large particles can include coarse dust, pollen, dust mite casings, etc. (from approximately 5um and up).

What does the graph mean?

The dynamic bar graph allows the user see an instant response to changing air quality. The graph is a simple and intuitive way to see large and small particles being counted. When the dynamic bar graph is short and does not extend out to the right, it means that small particles are being counted.

- Studies and Reports on Indoor Air Quality and Health
- Tips For Better Indoor Air Quality
- Customer Testimonials

When the dynamic bar graph is extended almost to the end, or completely to the end, it means that large particles are being counted. The DC1100 can count much faster than the bar graph can update so the graph really represents a summary of particles counted in the last 1/20th of a second.

Will one DC1100 Air Quality Monitor test all the air in my home at the same time?

No. Our monitor is light-weight and can easily be transferred to any room in your home. Let's say you have your the DC1100 in the kitchen during the day, but later that night you want to monitor the particle counts in the family room where everyone is. You simply unplug the monitor in one room and plug it in another. Our unit is reasonably priced making it affordable to purchase more than one unit.

Will the DC1100 Air Quality Monitor work in an office setting?

Yes. DC1100 Air Quality Monitor will work in your office. It has been designed to monitor office settings as well. Simply follow the same instructions for home use.

How do I read the history?

You access the history modes by using the mode and select buttons on the front of the monitor. There are three different histories provided, minute, hour and day. Minute history will give you an averaged particle count for each minute at a time, up to 60 minutes in the past. Hour history will give you an averaged particle count for each hour at a time, up to 24 hours in the past. Day history will give you an averaged particle count for each day at a time, up to 30 days in the past.

How does monitor mode work?

In monitor mode the unit sleeps and only comes on for 60 seconds every hour. A sampling of the air is taken and a count of large and small particles is saved to history. This mode is for people who do not want the unit to run continuously but would like to be able to look back in history to see what the counts have been over time.

Is there any maintenance required for my DC1100 Air Quality Monitor?

Only occasional cleaning, but it's so simple. All you do is use dust remover air (you can get this at any electronics store), spray it into the top vents on the back of the unit for about 10 seconds. That's all! This maintenance keeps the air moving freely so that the Air Quality Monitor will work as efficiently and effectively as possible.

Is there an email address that I can contact Dylos Corporation if I have any additional questions?

Yes, our tech support email address is support@dylosproducts.com

See what our Clients say about us

"...About 2 weeks ago we purchased a DC1100 air quality monitor from Dylos Corporation. This is a laser particle counter costing about $150 plus shipping. We will be using ours to do before and after testing of high efficiency air filter installations and duct sealing jobs. We had been looking at getting a laser particle counter for a while, but the high cost of all models we have seen had delayed us from buying one. Now it does not cost several thousand dollars for a laser particle counter to determine if we are doing a good job. We have had temperature and humidity data loggers for years to use as diagnostic tools on problem jobs. Now we can determine cleanliness of air in customer's homes as well, and we don't have to pay an annual license fee to use it either. So far we have been very pleased with the performance of the Dylos DC1100 air quality monitor"

...South Carolina

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AIR QUALITY DISPERSION MODELING OF OUTDOOR WOOD HYDRONIC HEATERS

Prepared for:

Central Boiler
20502 160th Street
Greenbush, MN 56726

Prepared by:

Peter H. Guldberg, C.C.M., Tech Environmental, Inc.
Robert J. Rossi, Ph.D., C.C.M., QEP, Tech Environmental, Inc.
Douglas Sheadel, C.C.M., Modeling Specialties

Tech Environmental, Inc.
1601 Trapelo Road, Suite 327
Waltham, MA 02451
(781) 890-2220

April 11, 2007

EXECUTIVE SUMMARY

Air dispersion modeling was performed with the U.S. AERMOD model and following EPA guidance to determine the effect of a Central Boiler Outdoor Wood Hydronic Heater (OWHH) on air quality for two emission scenarios. Air dispersion modeling assumed the OWHH was located a typical distance of 50 feet from either a one-story or a two-story house and had a stack top two feet above the roof peak of the nearest structure, following the chimney height installation instructions supplied by Central Boiler with every new unit. Five years of hourly meteorological data for Burlington, Vermont were utilized in the modeling.

The principal air pollutant emitted by OWHHs is particulate matter (PM). The Central Boiler Model 6048 was assumed to emit 60 g/hr of PM using the average of U.S. EPA test data[1] for emissions from Central Boiler furnaces of 10.7 g/kg-dry and a firing rate of 5.6 kg-dry/hour,[2] corresponding to a heat input rate of approximately 99,600 Btu/hour. Thus, the emission rate for the first scenario is 1.33-lb/MMBtu heat input. With 55% efficiency, the heat output rate is 54,300 Btu/hour and satisfies the peak heating-load for January in a northern State for a larger-than-average 2,800 sf home. The new EPA Phase 1 guideline of 0.60 lb/MMBtu was assumed in the second dispersion-modeling scenario, which translates to a mass emission rate of 27 g/hr. Two stack heights (20 ft and 35 ft) were analyzed for each emission rate.

The modeling results demonstrate that maximum predicted air concentrations from operation of a Central Boiler OWHH with an emission rate of either 60 g/hour or 27 g/hour are safely in compliance with the new 24-hour National Ambient Air Quality Standards (NAAQS) for fine particulate matter ($PM_{2.5}$) of 35 $\mu g/m^3$. The NAAQS have been established by EPA to protect the most sensitive groups in the population (for PM, these are people with asthma and respiratory disease) from any adverse effects, with a margin of safety. Full compliance with the NAAQS is demonstrated both on the homeowner's property and off-site for both stack heights.

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[1] U.S. EPA, "Emissions From Outdoor Wood-Burning Residential Hot Water Furnaces," EPA-600/R-98-017, February 1998, p. 22, Table 4-1a, average of Furnace B/B-1 through B-4 test results for a Central Boiler unit.

[2] Wood firing rate of 16 lb/hr (24% moisture) = 7.4 kg/hour = 5.6 kg-dry/hour.

1.0 INTRODUCTION

Central Boiler, Inc. of Greenbush, Minnesota is the manufacturer of Outdoor Wood Hydronic Heaters (OWHH). These are freestanding units that are located outside the structure being heated and consist of a firebox, water reservoir and ancillary mechanical equipment. The combustion of wood heats water that is pumped from the furnace to a heat exchanger located inside the structure. Combustion gasses are passed over or through heating tubes before being vented to the atmosphere through a metal stack. While similar in principle to other stick wood burning devices, these units are designed to provide continuous on-demand heat from the combustion of cordwood. The design allows the unit to be placed near the location of the wood supply. The thermal outputs range from 15,000 to over 50,000 Btu/hr. Figure 1 shows a typical installation of a Central Boiler OWHH.

The purpose of this study is to evaluate the air pollutant concentrations resulting from Central Boiler OWHH units when installed and operated according to manufacturer's instructions that are shipped with every new unit. A typical setting for this equipment would be a rural area that has an available nearby supply of firewood. The unit is typically installed 50 feet from the heated structure and over 100 feet from other residences. A stack height 2 feet above any nearby roofline is recommended. The modeling was performed with the U.S. Environmental Protection Agency (EPA) AERMOD model using emissions that were obtained from EPA testing of Central Boiler equipment. The EPA also provides guidance on modeling methodology and establishes National Ambient Air Quality Standards.

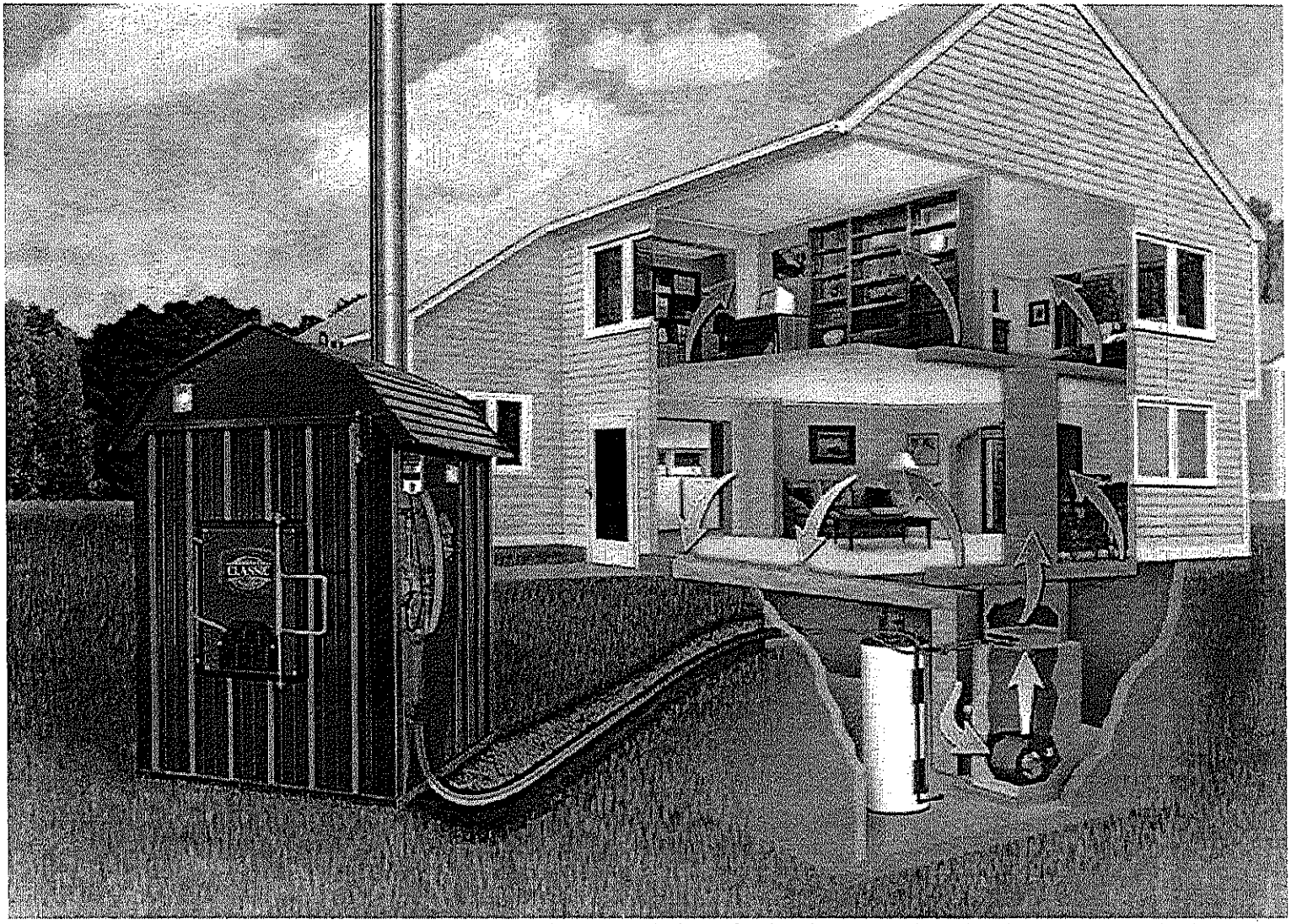


Figure 1: Concept Rendering Showing a Typical Installation of a Outdoor Wood Hydronic Heater Installation

2.0 AIR QUALITY STANDARDS

The principal air pollutant emitted by OWHHs is particulate matter (PM). EPA has established National Ambient Air Quality Standards (NAAQS) for both coarse (PM_{10}) and fine ($PM_{2.5}$) particulate matter. The PM_{10} standard applies to particles with a mass-mean diameter of 10 microns or less, while the $PM_{2.5}$ standard is keyed to particles 2.5 microns in diameter or less. While both long-term (annual) and short-term (24-hour) standards have been established, the 24-hour standards are the controlling set because of their more stringent limits. Also, the $PM_{2.5}$ standard is more stringent than the PM_{10} standard. Thus, only the 24-hour $PM_{2.5}$ levels are examined in this study.

The 24-hour $PM_{2.5}$ standard is 35 $\mu g/m^3$, measured as a 3-year average of 98^{th}-percentile concentrations. In a one-year period, the 8th-highest 24-hour value represents the 98^{th}-percentile concentration. For compliance purposes, the $PM_{2.5}$ design concentration is the 3-year average of the highest, 8^{th}-highest (H8H) values in each year at any receptor location. The US EPA added special processing for $PM_{2.5}$ in the latest versions of AERMOD (versions 06341 and 07026) to predict the design concentrations for each receptor. AERMOD now calculates the N-year average H8H 24-hour average $PM_{2.5}$ concentration at each receptor over the N years of meteorological data provided. The U.S. EPA considers the five-year average of the H8H 24-hour $PM_{2.5}$ values at each receptor to be unbiased estimates of the 3-year average H8H values, since US EPA guidance requires the use of five years of meteorological data when the data are from an off-site National Weather Service meteorological station.[3] Thus, the five-year average H8H values from the AERMOD model are the design values used to establish compliance with the NAAQS.

[3] US EPA, "Addendum User's Guide for the AMS/EPA Regulatory Model – AERMOD (EPA-454/B-03-001, September 2004)", pp. 5 – 7, December 2006.

3.0 OWHH EMISSIONS AND STACK PARAMETERS

Particulate matter from a fuel combustion process contains a wide distribution of particle sizes. For wood combustion, these range from relatively larger carbon particles (soot) down to sub-micron organic compound aerosols. Research studies of OWHH emissions have used sampling methods that capture the full size distribution of PM, solid particles and condensible organics. EPA particle size distribution data for wood boilers reveal that typically 90% of the total PM mass has a diameter of 10 microns or less, and 76% has a diameter of 2.5 microns or less.[4] As a conservative assumption in this study, all PM emissions were assumed to be $PM_{2.5}$.

Air dispersion modeling assumed the OWHH was located a typical distance of 50 feet from a house having a 30-foot by 50-foot footprint. The OWHH building had dimensions of 5.4 feet by 5.8 feet and stood 6 feet high (a Central Boiler Model 6048). Four modeling cases were examined:

- Case 1: One-story house, 18-foot roof peak, 20-foot stack, PM = 60 g/hr
- Case 2: Two-story house, 33-foot roof peak, 35-foot stack, PM = 60 g/hr
- Case 3: One-story house, 18-foot roof peak, 20-foot stack, PM = 27 g/hr
- Case 4: Two-story house, 33-foot roof peak, 35-foot stack, PM = 27 g/hr

Central Boiler has recommended since 1996 that OWHH stacks be installed to a height two feet above the roof-line of the nearest structure. These chimney height installation instructions accompany every new Central Boiler OWB that is sold and are contained in the industry's Best Burn Practices guideline attached to this report.

The stack gas exit temperature and exit velocity used in this analysis represent typical values measured in Central Boiler's emissions test laboratory in Greenbush, Minnesota for the OWHHs. All stack and emission values used in this study are summarized in Table 1.

[4] EPA publication AP-42, Section 1.6.

TABLE 1

STACK PARAMETERS AND EMISSIONS FOR AIR DISPERSION MODELING

Parameter	English Units	Metric Units
Stack Height Case 1 Case 2	 20 feet 35 feet	 6.1 m 10.7 m
Stack Exit Diameter	8 inches	0.2 m
Stack Exit Velocity	7.2 feet/sec.	2.2 m/s
Stack Exit Temperature	350° F	449.9° K
$PM_{2.5}$ Emission Rate Existing OWHH Models Model Meeting EPA Phase 1 Limit	 0.13 lb/hr 0.06 lb/hr	 60.0 g/hr 27.1 g/hr

4.0 MODELING RESULTS AND CONCLUSIONS

The air dispersion modeling reveals that the boiler operation produces $PM_{2.5}$ concentrations ranging from 2.0 to 8.4 $\mu g/m^3$ under the four modeled scenarios. The results are summarized in Tables 3 and 4, and the model output is appended to this report. The results are also shown graphically on $PM_{2.5}$ contour maps presented in four figures at the end of this section. All maximum predicted $PM_{2.5}$ concentrations are in compliance with the National Ambient Air Quality Standards (NAAQS) for all stack heights and emission rates.

The highest predicted concentration of 8.4 $\mu g/m^3$ was obtained using the 60 g/hr emission rate and 20-foot stack height. Both decreasing the emission rate and increasing the stack height reduces the expected ambient concentration. The lowest concentration was predicted under the assumed 27 g/hr emission rate and 35-foot stack height. The modeling results are presented without background levels or any assumption as to where the OWHH is located. However, since the OWHH are typically located in rural settings where abundant nearby wood is available and background levels are low, the introduction of 8.4 $\mu g/m^3$ or less from an OWHH would not adversely affect air quality and total $PM_{2.5}$ concentrations would remain well below the the $PM_{2.5}$ NAAQS of 35 $\mu g/m^3$.

TABLE 3

24-HOUR $PM_{2.5}$ AIR MODELING RESULTS FOR
CENTRAL BOILER MODEL 6048 WITH
PM EMISSIONS OF 60 G/HR
($\mu g/m^3$)

	Case 1	Case 2
Roof Height (ft) Stack Height (ft)	18 20	33 35
Assume All PM is $PM_{2.5}$		
5-Year Average of H8H	8.4	4.5
NAAQS	35.0	35.0

TABLE 4

24-HOUR $PM_{2.5}$ AIR MODELING RESULTS FOR
CENTRAL BOILER MODEL 6048 WITH
PM EMISSIONS OF 27 G/HR
($\mu g/m^3$)

	Case 3	Case 4
Roof Height (ft) Stack Height (ft)	18 20	33 35
Assume All PM is $PM_{2.5}$		
5-Year Average of H8H	3.8	2.0
NAAQS	35.0	35.0

OUTDOOR WOOD FURNACE BEST BURN PRACTICES

1. Read and follow all operating instructions supplied by the manufacturer.

2. FUEL USED: Only those listed fuels recommended by the manufacturer of your unit. Never use the following: trash, plastics, gasoline, rubber, naphtha, household garbage, material treated with petroleum products (particle board, railroad ties and pressure treated wood), leaves, paper products, and cardboard.

3. LOADING FUEL: For a more efficient burn, pay careful attention to loading times and amounts. Follow the manufacturer's written instructions for recommended loading times and amounts.

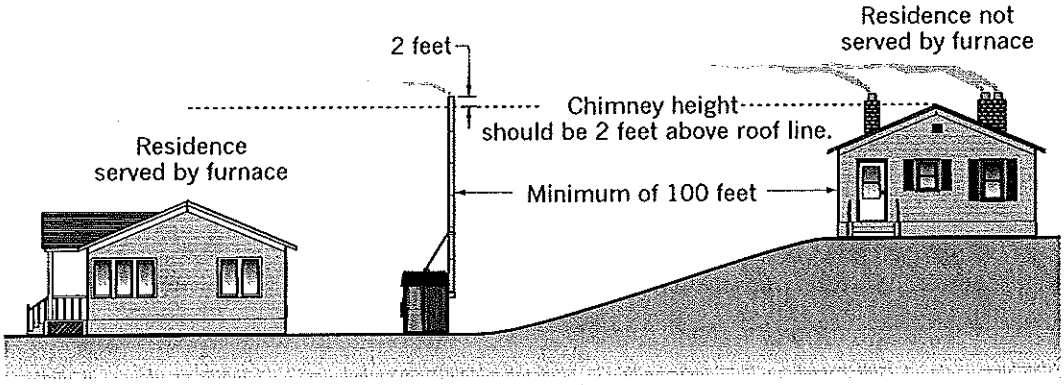
4. STARTERS: Do not use lighter fluids, gasoline, or chemicals.

5. LOCATION: It is recommended that the unit be located with due consideration to the prevailing wind direction.

   - Furnace should be located no less than 100 feet from any residence not served by the furnace.

   - If located within 100 feet to 300 feet to any residence not served by the furnace, it is recommended that the stack be at least 2 feet higher than the peak of that residence.

Chimney Height Installation Scenario



6. Always remember to comply with all applicable state and local codes.

HPBA
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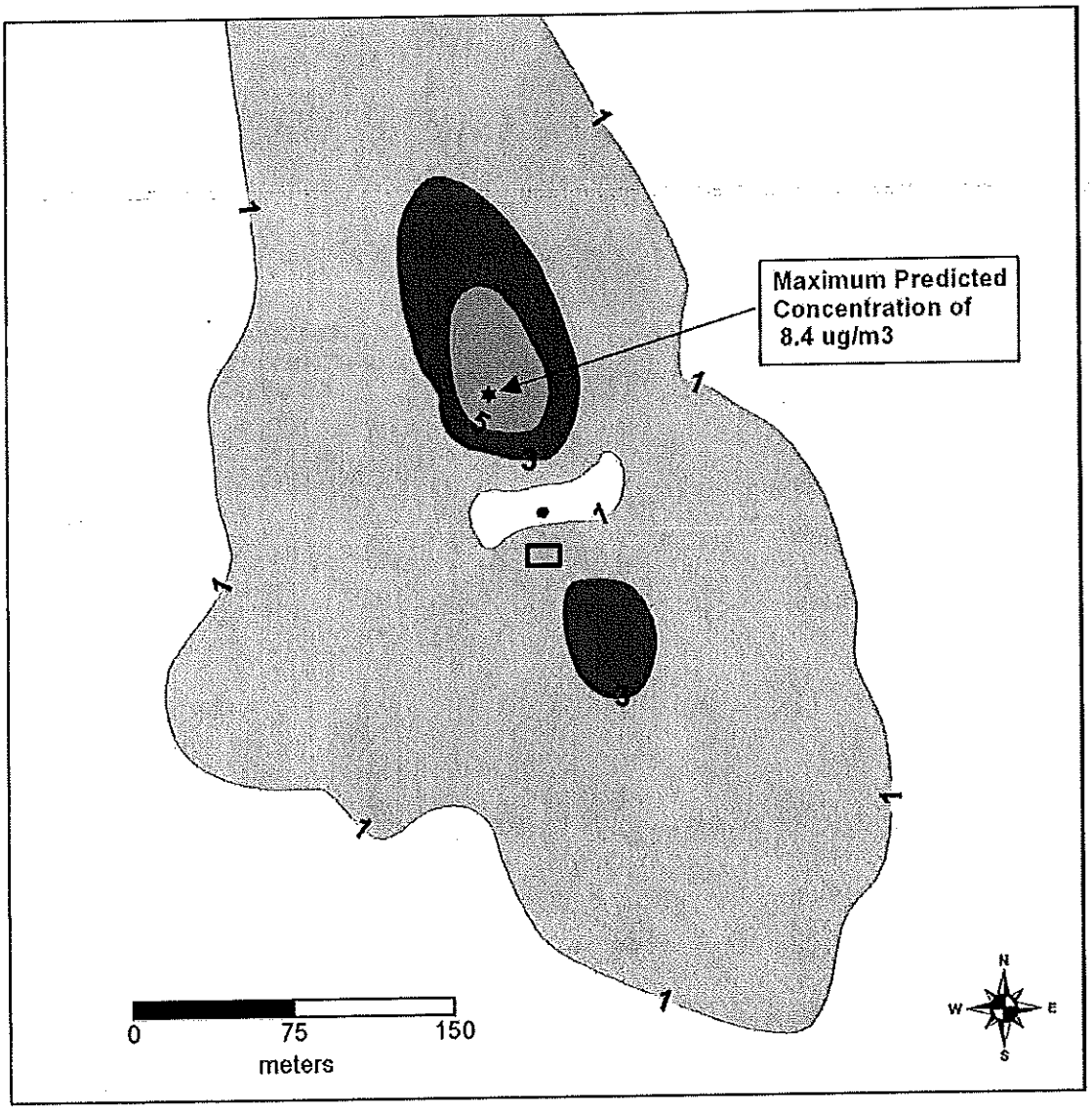
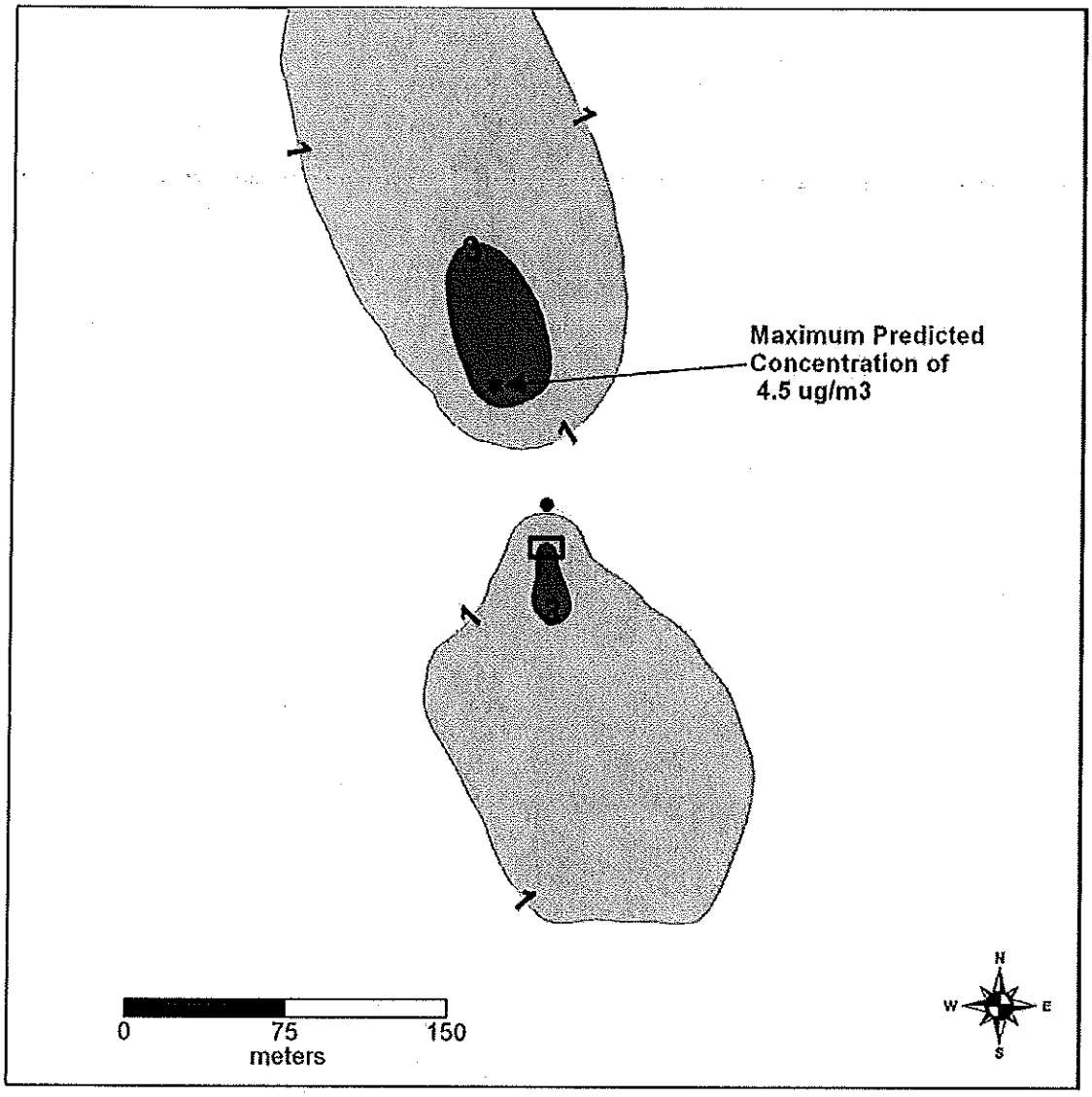
OUTDOOR FURNACE MANUFACTURERS CAUCUS



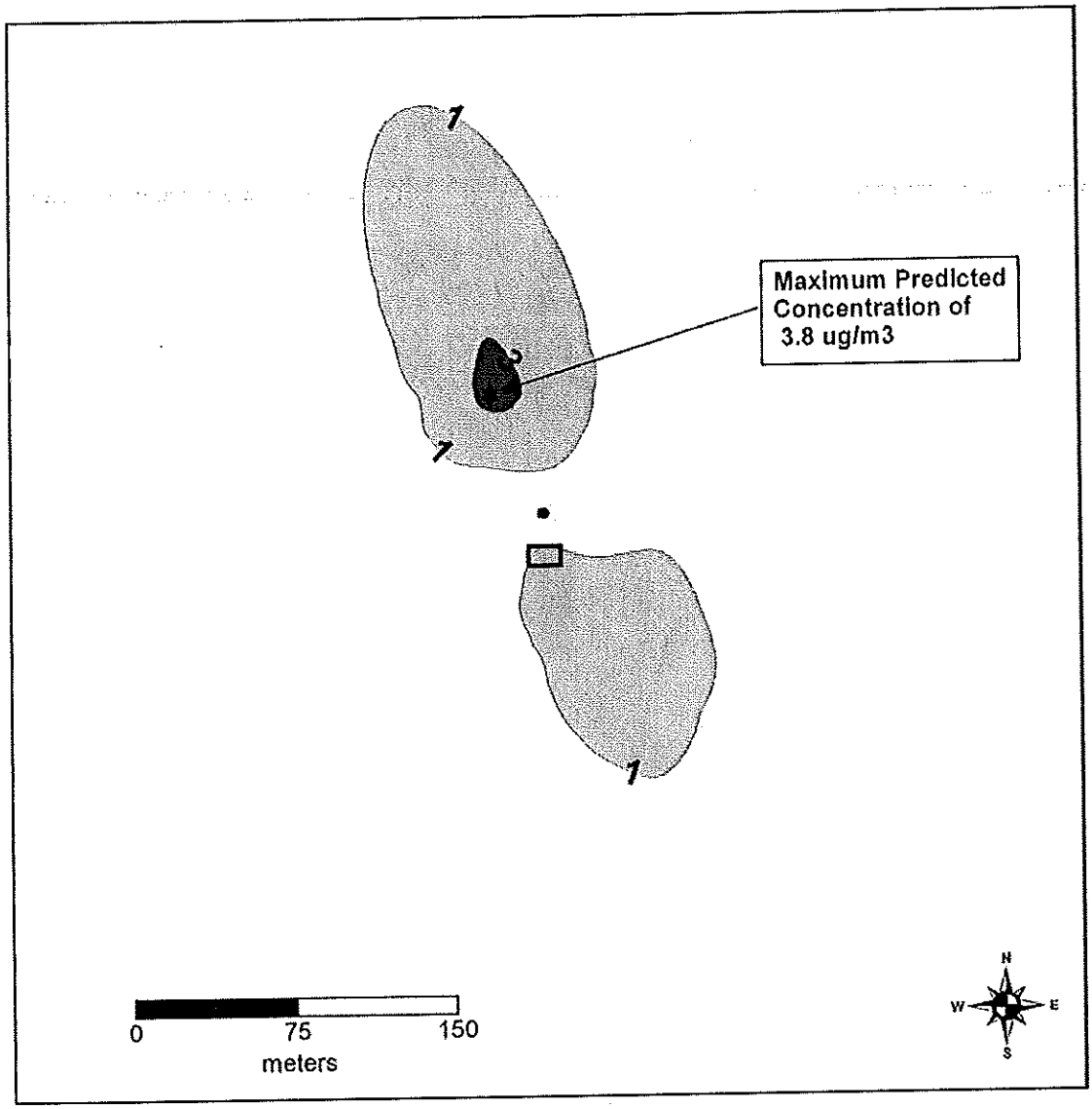
20-FOOT WOOD BOILER STACK (CASE 1)

Five-Year Average 24-Hour H8H Concentations for 60 grams/hour (ug/m3)



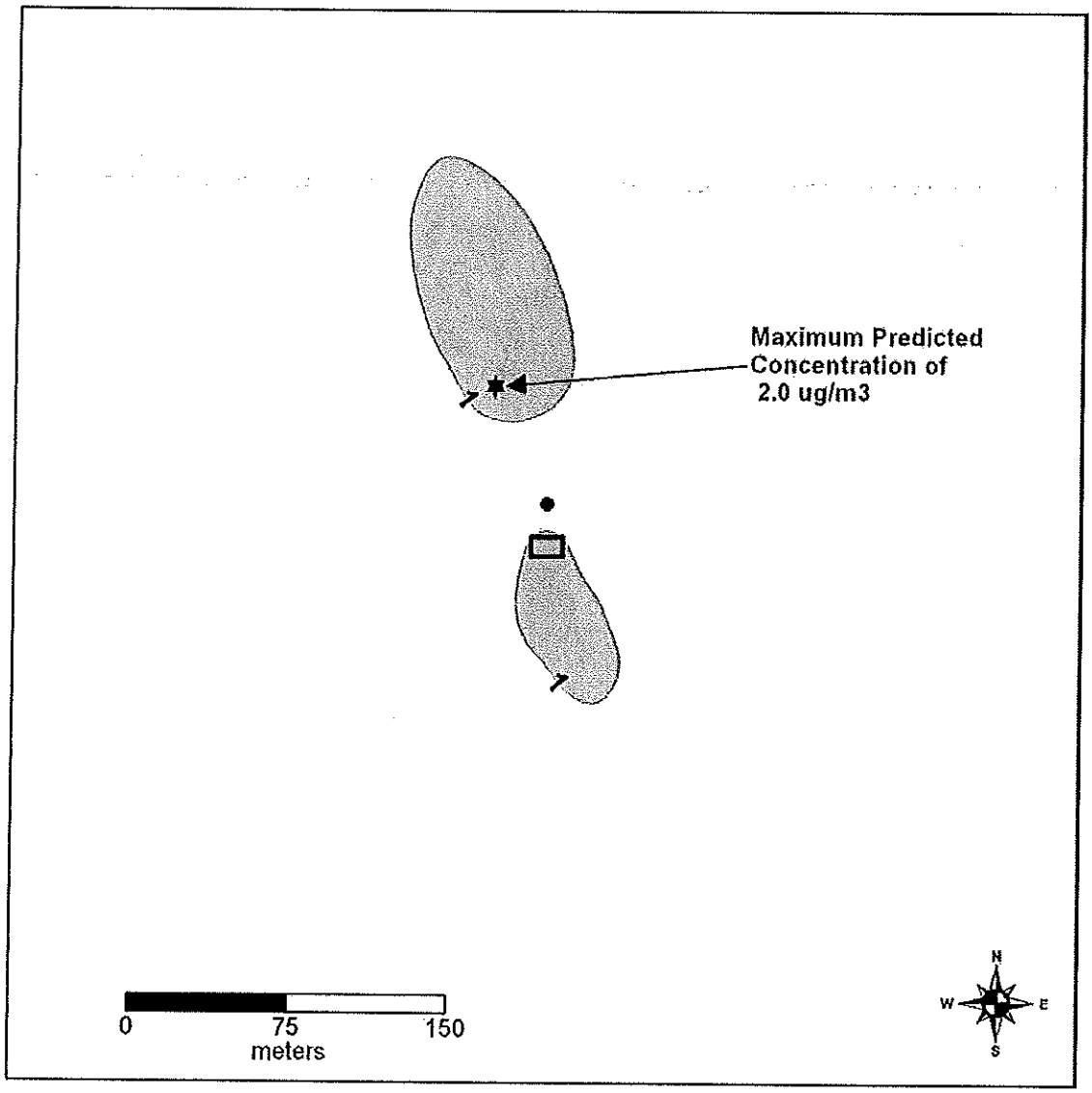
35-FOOT WOOD BOILER STACK (CASE 2)

Five-Year Average 24-Hour H8H Concentations for 60 grams/hour (ug/m3)



35-FOOT WOOD BOILER STACK (CASE 3)

Five-Year Average 24-Hour H8H Concentations for 27.1 grams/hour (ug/m3)



35-FOOT WOOD BOILER STACK (CASE 4)

Five-Year Average 24-Hour H8H Concentations for 27.1 grams/hour (ug/m3)

Maximum 24-Hour $PM_{2.5}$ Concentration vs. Stack Distance from House
For an EPA-Certified Phase 2 Outdoor Wood-Burning Furnace